APPENDIX D
HYDROLOGY, GEOMETRY, AND METEROLOGICAL INPUT DATA FOR SSTEMP

This page left intentionally blank.

TABLE OF CONTENTS

TABLE OF CONTENTS ..... **I**
LIST OF TABLES ..... **I**
LIST OF FIGURES ..... **II**
LIST OF ACRONYMS ..... **III**

D 1.0 INTRODUCTION *1*
D 2.0 HYDROLOGY ***1***
D2.1 Segment Inflow *1*
D2.2 Inflow Temperature *3*
D2.3 Segment Outflow *4*
D2.4 Accretion Temperature *4*
D 3.0 GEOMETRY *6*
D3.1 Latitude *6*
D3.2 Dam at Head of Segment *6*
D3.3 Segment Length *6*
D3.4 Upstream Elevation *6*
D3.5 Downstream Elevation *7*
D3.6 Width's A and Width's B Term *7*
D3.7 Manning's n or Travel Time *9*
D 4.0 METEOROLOGICAL PARAMETERS *11*
D4.1 Air Temperature *11*
D4.2 Maximum Air Temperature *11*
D4.3 Relative Humidity *12*
D4.4 Wind Speed *12*
D4.5 Ground Temperature *13*
D4.6 Thermal Gradient *13*
D4.7 Possible Sun *13*
D4.8 Dust Coefficient *14*
D4.9 Ground Reflectivity *14*
D4.10 Solar Radiation *14*
D 5.0 SHADE *15*
D 6.0 REFERENCES *16*

LIST OF TABLES

Table D.1 Assessment Units and Modeled Dates *1*
Table D.2 Drainage Areas for Estimating Flow by Drainage Area Ratios *2*
Table D.3 Parameters for Estimating Flow using USGS Regression Model *3*
Table D.4 Inflow *3*
Table D.5 Mean Daily Water Temperature *4*

Table D.6 Segment Outflow *4*
Table D.7 Mean Annual Air Temperature as an Estimate for Accretion Temperature *5*
Table D.8 Assessment Unit Latitude *6*
Table D.9 Presence of Dam at Head of Segment *6*
Table D.10 Segment Length *6*
Table D.11 Upstream Elevations *7*
Table D.12 Downstream Elevations *7*
Table D.13 Width's A and Width's B Terms *8*
Table D.14 Manning's n Values *10*
Table D.15 Mean Daily Air Temperature *11*
Table D.16 Mean Daily Relative Humidity *12*
Table D.17 Mean Daily Wind Speed *13*
Table D.18 Mean Annual Air Temperature as an Estimate for Ground Temperature *13*
Table E.19 Mean Daily Solar Radiation *14*
Table D.20 Percent Shade *15*

LIST OF FIGURES

Figure D.1 Wetted Width versus Flow for Assessment Unit NM-2209.A_20 ..... *8*
Figure D.2 Wetted Width versus Flow for Assessment Unit NM-2106.A_12 ..... *8*

LIST OF ACRONYMS

4Q3	Four-consecutive day discharge that has a recurrence interval of three years
cfs	Cubic Feet per Second
GIS	Geographic Information Systems
GPS	Global Positioning System
IOWDM	Input and Output for Watershed Data Management
mi^2	Square Miles
^oC	Degrees Celcius
SEE	Standard Error of Estimate
SSTEMP	Stream Segment Temperature
SWSTAT	Surface-Water Statistics
TMDL	Total Maximum Daily Load
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
WinXSPRO	Windows-Based Stream Channel Cross-Section Analysis

This page left intentionally blank.

D 1.0 INTRODUCTION

This appendix provides site-specific hydrology, geometry, and meteorological data for input into the Stream Segment Temperature (SSTEMP) Model (Bartholow 2002). Hydrology variables include segment inflow, inflow temperature, segment outflow, and accretion temperature. Geometry variables are latitude, segment length, upstream and downstream elevation, Width's A-term, Width's B-term, and Manning's n. Meterological inputs to SSTEMP Model include air temperature, relative humidity, windspeed, ground temperature, thermal gradient, possible sun, dust coefficient, ground reflectivity, and solar radiation. In the following sections, these parameters are discussed in detail for each assessment unit to be modeled using SSTEMP Model. The assessment units were modeled on the day of the maximum recorded thermograph measurement. The assessment units and modeled dates are defined as follows:

Table D.1 Assessment Units and Modeled Dates

Assessment Unit ID	Assessment Unit Description	Modeled Date
NM-2106.A_10	East Fork Jemez (VCNP boundary to headwaters)	7/6/2001
NM-2106.A_12	Jaramillo Creek (East Fork Jemez to headwaters)	7/7/2001

D 2.0 HYDROLOGY

D2.1 Segment Inflow

This parameter is the *mean daily* flow at the top of the stream segment. If the segment begins at an effective headwater, the flow is entered into SSTEMP Model as zero. Flow data from USGS gages were used when available. To be conservative, the lowest four-consecutive-day discharge that has a recurrence interval of three years but that does not necessarily occur every three years (4Q3) was used as the inflow instead of the mean daily flow. These critical low flows were used to decrease assimilative capacity of the stream to adsorb and disperse solar energy. The 4Q3 would be determined for gaged sites using a log Pearson Type III distribution through "*Input and Output for Watershed Data Management*" (IOWDM) software, Version 4.1 (USGS 2002a) and "*Surface-Water Statistics*" (SWSTAT) software, Version 4.1 (USGS 2002b).

Discharges for ungaged sites on gaged streams were estimated based on methods published by Thomas *et al.* (1997). If the drainage area of the ungaged site is between 50 and 150 percent of the drainage area of the gaged site, the following equation is used:

$$Q_u = Q_g \left(\frac{A_u}{A_g} \right)^{0.5}$$

where,

Q_u = Area weighted 4Q3 at the ungaged site (cubic feet per second [cfs])
Q_g = 4Q3 at the gaged site (cfs)
A_u = Drainage area at the ungaged site (square miles [mi^2])
A_g = Drainage area at the gaged site (mi^2)

Drainage areas for assessment units to which this method was applied are summarized in the following table:

Table D.2 Drainage Areas for Estimating Flow by Drainage Area Ratios

Assessment Unit	USGS Gage	Drainage Area from Gage (mi^2)	Drainage Area from Top of AU (mi^2)	Drainage Area from Bottom of AU (mi^2)	Ratio of DA of Ungaged (upstream) to Gaged Site	Ratio of DA of Ungaged (downstream) to Gaged Site
NM-2106.A_10	—[(a)]	—	—[(b)]	43.727	—	—
NM-2106.A_12	—[a)]	—	—[(b)]	14.997	—	—

Notes:
[(a)]Regression method developed by Waltemeyer (2002) was used to estimate flows since this is an ungaged stream.
[(b)]Assessment unit begins at headwaters.

mi^2 = Square miles
USGS = U.S. Geological Survey
AU = Assessment Unit

4Q3 derivations for ungaged streams were based on analysis methods described by Waltemeyer (2002). Two regression equations for estimating 4Q3 were developed based on physiographic regions of New Mexico (i.e., statewide and mountainous regions above 7,500 feet in elevation). The following statewide regression equation is based on data from 50 gaging stations with non-zero discharge (Waltemeyer 2002):

$$4Q3 = 1.2856 \times 10^{-4}\ DA^{0.42}\ P_w^{\ 3.16}$$

where,

4Q3 = Four-day, three-year low-flow frequency (cfs)
DA = Drainage area (mi^2)
P_w = Average basin mean winter precipitation (inches)

The average standard error of estimate (SEE) and coefficient of determination are 126 and 48 percent, respectively, for this regression equation (Waltemeyer 2002). The following regression equation for mountainous regions above 7,500 feet in elevation is based on data from 40 gaging stations with non-zero discharge (Waltemeyer 2002):

$$4Q3 \quad = \quad 7.3287 \times 10^{-5}\ DA^{0.70}\ P_w^{\ 3.58}\ S^{1.35}$$

where,

4Q3 = Four-day, three-year low-flow frequency (cfs)
DA = Drainage area (mi^2)
P_w = Average basin mean winter precipitation (inches)
S = Average basin slope (percent)

The average SEE and coefficient of determination are 94 and 66 percent, respectively, for this regression equation (Waltemeyer 2002). The drainage areas, average basin mean winter precipitation, and average basin slope for assessment units where this regression method was used are presented in the following table:

Table D.3 Parameters for Estimating Flow using USGS Regression Model

Assessment Unit	Regression Model[(a)]	Average Elevation for Assessment Unit (feet)	Mean Basin Winter Precipitation (inches)	Average Basin Slope (unitless)
NM-2106.A_10	Mountainous	8,911	12.58	0.181
NM-2106.A_12	Mountainous	9,035	12.63	0.182

Notes:
mi^2 = Square miles
[(a)] Waltemeyer (2002)

Based on the methods described above, the following values were estimated for inflow:

Table D.4 Inflow

Assessment Unit	Ref.	4Q3 (cfs)	DAt (mi^2)	DAg (mi^2)	Pw (in)	S unitless	Inflow (cfs)
NM-2106.A_10	N/A	–	0.215	–	12.58	0.181	0.00[(1)]
NM-2106.A_12	N/A	–	0.04	–	12.63	0.182	0.00[(1)]

Notes:
N/A = Not applicable, assessment unit begins at headwaters.
Ref. = Reference

cfs = cubic feet per second
mi^2 = Square miles
in = Inches
Pw = Mean winter precipitation
DAt = Drainage area from top of segment
DAb = Drainage area from bottom of segment
DAg = Drainage area from USGS gage
S = Average basin slope
[(1)] Inflow is zero because assessment unit begins at headwaters.

D2.2 Inflow Temperature

This parameter represents the *mean daily* water temperature at the top of the segment. 2001 data from thermographs positioned at the top of the assessment unit were used when possible. If the segment began at a true headwater, the temperature entered was zero degrees Celcius (^oC) (zero

flow has zero heat). The following inflow temperatures for impaired assessment units were modeled in SSTEMP:

Table D.5 Mean Daily Water Temperature

Assessment Unit	Upstream Thermograph Location	Inflow Temp. (ºC)	Inflow Temp. (ºF)
NM-2106.A_10	East Fork Jemez below La Jara	0	32.0
NM-2106.A_12	Jaramillo Creek above Cerro Piñon	0	32.0

Notes:
ºC = Degrees Celcius
ºF = Degrees Farenheit

D2.3 Segment Outflow

Flow data from USGS gages were used when available. To be conservative, the 4Q3 was used as the segment outflow. These critical low flows were used to decrease assimilative capacity of the stream to adsorb and disperse solar energy. Outflow was estimated using the methods described in Section 2.1. The following table summarizes 4Q3s used in the SSTEMP Model:

$$4Q3 \quad = \quad 7.3287 \times 10^{-5}\ DA^{0.70}\ P_w^{\ 3.58}\ S^{1.35}$$

Table D.6 Segment Outflow

Assessment Unit	Ref.	4Q3[(1)] (cfs)	DAb (mi^2)	DAg (mi^2)	Pw (in)	S unitless	Outflow (cfs)
NM-2106.A_10	(a)	–	43.727	–	12.58	0.181	0.888
NM-2106.A_12	(a)	–	14.997	–	12.63	0.182	0.429

Notes:
Ref. = Reference
(a) Waltemeyer 2002

cfs = cubic feet per second
mi^2 = Square miles
in = Inches
Pw = Mean winter precipitation
(1) xxx

DAb = Drainage area from bottom of segment
DAg = Drainage area from USGS gage
S = Average basin slope

D2.4 Accretion Temperature

The temperature of the lateral inflow, barring tributaries, generally should be the same as groundwater temperature. In turn, groundwater temperature may be approximated by the mean annual air temperature. Mean annual air temperature for 2001 was used in the absence of measured data. The following table presents the mean annual air temperature for each assessment unit:

Table D.7 Mean Annual Air Temperature as an Estimate for Accretion Temperature

Assessment Unit	Ref.	Mean Annual Air Temperature (^oC)	Mean Annual Air Temperature (^oF)
NM-2106.A_10	(a)	6.62	43.924
NM-2106.A_12	(a)	6.62	43.924

Notes:
Ref. = References for Weather Station Data are as follows:
(a) New Mexico State University Climate Network (Jemez METAR, Elevation 2,438 meters; Latitude 35° 50' 28" N, Longitude 106° 37' 8" W), ***2001***
ºF = Degrees Farenheit
ºC = Degrees Celcius

D 3.0 GEOMETRY

D3.1 Latitude

Latitude refers to the position of the stream segment on the earth's surface. Latitude is generally determined in the field with a global positioning system (GPS) unit. Latitude for each assessment unit is summarized below:

Table D.8 Assessment Unit Latitude

Assessment Unit	Latitude (decimal degrees)
NM-2106.A_10	35.87
NM-2106.A_12	35.88

D3.2 Dam at Head of Segment

The following assessment units have a dam at the upstream end of the segment with a constant, or nearly constant diel release temperature:

Table D.9 Presence of Dam at Head of Segment

Assessment Unit	Dam?
NM-2106.A_10	No
NM-2106.A_12	No

D3.3 Segment Length

Segment length was determined with National Hydrographic Dataset Reach Indexing GIS tool. The segment lengths are as follows:

Table D.10 Segment Length

Assessment Unit	Length (miles)
NM-2106.A_10	8.66
NM-2106.A_12	10.01

D3.4 Upstream Elevation

The following upstream elevations were determined with National Hydrographic Dataset Reach Indexing GIS tool.

Table D.11 Upstream Elevations

Assessment Unit	Upstream Elevation (feet)
NM-2106.A_10	8,900
NM-2106.A_12	9,380

D3.5 Downstream Elevation

The following downstream elevations were determined with National Hydrographic Dataset Reach Indexing GIS tool.

Table D.12 Downstream Elevations

Assessment Unit	Downstream Elevation (feet)
NM-2106.A_10	8,450
NM-2106.A_12	8,480

D3.6 Width's A and Width's B Term

Width's B Term was calculated as the slope of the regression of the natural log of width and the natural log of flow. Width-versus-flow regression analyses were prepared by entering cross-section field data into a Windows-Based Stream Channel Cross-Section Analysis (WINXSPRO) Program (U.S. Department of Agriculture [USDA] 1998). Theoretically, the Width's A Term is the untransformed Y-intercept. However, because the width versus discharge relationship tends to break down at very low flows, the Width's B-Term was first calculated as the slope and Width's A-Term was estimated by solving for the following equation:

$$W = A \times Q^{B}$$

where,

W = Known width (feet)
A = Width's A-Term (seconds per square foot)
Q = Known discharge (cfs)
B = Width's B-Term (unitless)

The following table summarizes Width's A- and B-Terms for assessment units requiring temperature TMDLs:

Table D.13 Width's A and Width's B Terms

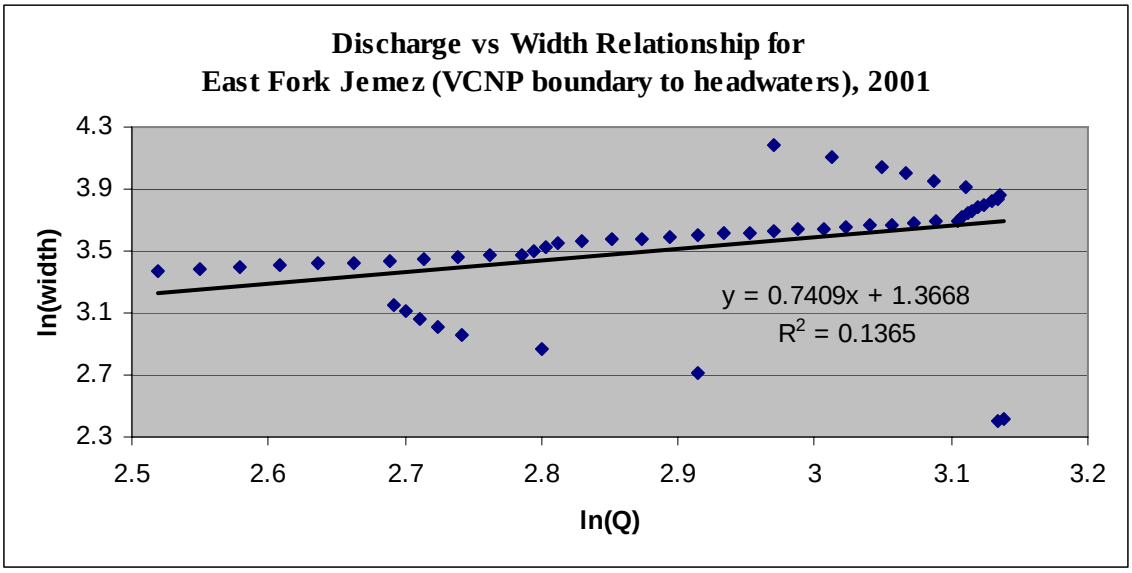
Assessment Unit	Width's B-Term	Width's A-Term [1]
NM-2106.A_10	0.741	3.92
NM-2106.A_12	0.935	3.26

[1] *A=e^constant from regression*

The following figures present the detailed calculations for the Width's B-Term.

Measurements were collected at one site within these assessment units. The regression of natural log of width and natural log of flow for each location is as follows:

Figure D.1 Wetted Width versus Flow for Assessment Unit NM-2106.A_10



SUMMARY OUTPUT

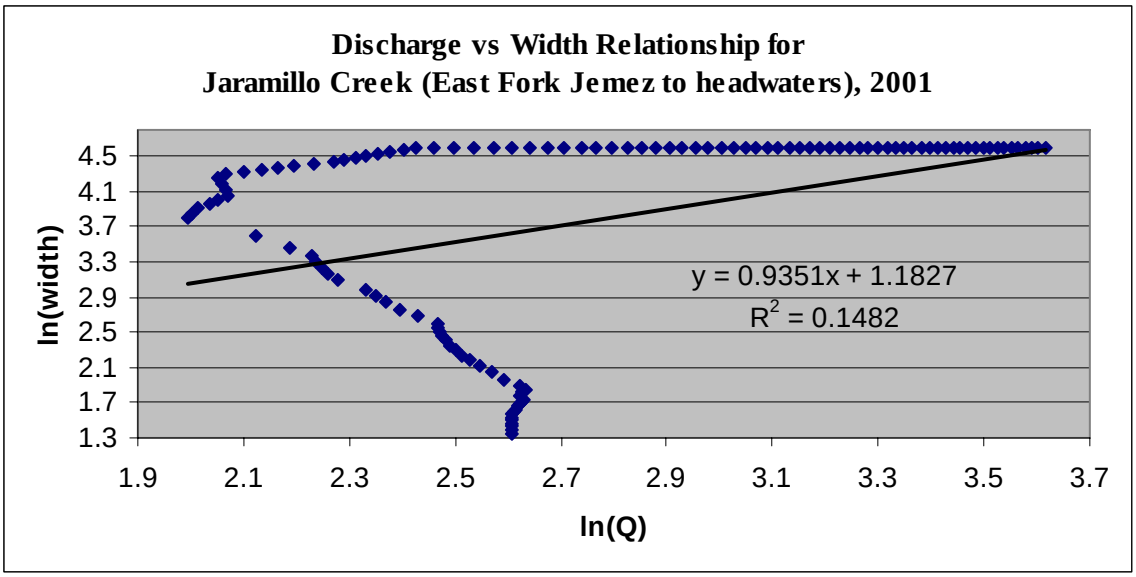
Regression Statistics	
Multiple R	0.369488671
R Square	0.136521878
Adjusted R	0.119590935
Standard E	0.348929007
Observatio	53

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regressior	1	0.981737183	0.981737	8.063454	0.006471864
Residual	51	6.209324031	0.121751		
Total	52	7.191061214			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	1.366762126	0.760006876	1.798355	0.07804	-0.15901417	2.892538422	-0.15901417	2.892538422
X Variable	0.740870119	0.260904478	2.839622	0.006472	0.217082927	1.264657311	0.217082927	1.264657311

Figure D.2 Wetted Width versus Flow for Assessment Unit NM-2106.A_12



SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.384906671
R Square	0.148153145
Adjusted R	0.140934104
Standard E	1.066021269
Observatio	120

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	23.32185542	23.32186	20.52255	1.41991E-05
Residual	118	134.0953589	1.136401		
Total	119	157.4172144			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	1.182691194	0.573004028	2.064019	0.041208	0.047988452	2.317394	0.047988452	2.317393936
X Variable	0.935075939	0.206410223	4.530182	1.42E-05	0.526327946	1.343824	0.526327946	1.343823931

D3.7 Manning's n or Travel Time

Site-specific values generated from WINXSPRO were used for Manning's n. The following table summarizes the input values:

Table D.14 Manning's n Values

Assessment Unit	Manning's n
NM-2106.A_10	0.031
NM-2106.A_12	0.033

D 4.0 METEOROLOGICAL PARAMETERS

D4.1 Air Temperature

This parameter is the mean daily air temperature for the assessment unit (or average daily temperature at the mean elevation of the assessment unit). Air temperature will usually be the single most important factor in determining mean daily water temperature. Although air temperatures are usually measured directly (in the shade) using air thermographs and adjusted to what the temperature would be at the mean elevation of the assessment unit, no air thermographs were deployed during the VCNP intensive survey. The following table summarizes mean daily air temperatures for each assessment unit (for its modeled date) requiring a temperature Total Maximum Daily Load (TMDL):

Table D.15 Mean Daily Air Temperature

Assessment Unit	Elevation at Air Thermograph Location (meters)	Measured Mean Daily Air Temperature (°C) [(a)]	Mean Elevation for Assessment Unit (meters)	Adjusted Mean Daily Air Temperature (°C)	Adjusted Mean Daily Air Temperature (°F)
NM-2106.A_10	2,438	20.06	2,716	18.24	64.83
NM-2106.A_12	2,438	20.24	2,754	18.17	64.71

Notes:
(a) *New Mexico State University Climate Network (Jemez METAR, Elevation 2,438 meters; Latitude 35° 50' 28" N, Longitude 106° 37' 8" W)*

ºF = Degrees Farenheit
ºC = Degrees Celcius

The adiabatic lapse rate was used to correct for elevational differences from the met station:

$$T_a = T_o + C_t \times (Z - Z_o)$$

where,

T_a = air temperature at elevation E (°C)
T_o = air temperature at elevation E_o (°C)
Z = mean elevation of segment (meters)
Z_o = elevation of station (meters)
C_t = moist-air adiabatic lapse rate (-0.00656 °C/meter)

D4.2 Maximum Air Temperature

Unlike the other variables, the maximum daily air temperature overrides only if the check box is checked. If the box is not checked, the SSTEMP Model estimates the maximum daily air temperature from a set of empirical coefficients (Theurer et al., 1984 as cited in Bartholow 2002)

and will print the result in the grayed data entry box. A value cannot be entered unless the box is checked.

D4.3 Relative Humidity

Relative humidity data were obtained from the Western Regional Climate Center web site (www.wrcc.dri.edu) or the New Mexico State University Climate Network (http://weather.nmsu.edu/data/data.htm). The data were corrected for elevation and temperature using the following equation:

$$R_h = R_o \times \left(1.0640^{(To-Ta)}\right) \times \left(\frac{T_a + 273.16}{T_o + 273.16}\right)$$

where,

R_h = relative humidity for temperature T_a (decimal)
R_o = relative humidity at station (decimal)
T_a = air temperature at segment (°C)
T_o = air temperature at station (°C)

The following table presents the adjusted mean daily relative humidity for each assessment unit:

Table D.16 Mean Daily Relative Humidity

Assessment Unit	Ref.	Mean Daily Air Temp. at Weather Station (°C)	Mean Daily Air Temperature at AU (°C)	Mean Daily Relative Humidity at Weather Station (percent)	Mean Daily Relative Humidity for AU (percent)
NM-2106.A_10	(a)	20.06	18.24	22.198	24.70
NM-2106.A_12	(b)	20.24	18.17	24.521	27.68

Notes:
Ref. = References for Weather Station Data are as follows:

(a) *New Mexico State University Climate Network (Jemez METAR, Elevation 2,438 meters; Latitude 35° 50' 28" N, Longitude 106° 37' 8" W)* ***July 6, 2003***
(b) *New Mexico State University Climate Network (Jemez METAR, Elevation 2,438 meters; Latitude 35° 50' 28" N, Longitude 106° 37' 8" W)* ***July 7, 2003***

AU = Assessment Unit
ºC = Degrees Celcius

D4.4 Wind Speed

Average daily wind speed data were obtained from the New Mexico State University Climate Network (http://weather.nmsu.edu/data/data.htm). The following table presents the mean daily wind speed for each assessment unit:

Table D.17 Mean Daily Wind Speed

Assessment Unit	Ref.	Mean Daily Wind Speed (miles per hour)	Date
NM-2106.A_10	(a)	2.0	7/6/2001
NM-2106.A_12	(a)	0.958	7/7/2001

Notes:
Ref. = References for Weather Station Data are as follows:
(a) *New Mexico State University Climate Network (Coyote RAWS, Elevation 2,682 meters; Latitude 36° 4' N, Longitude 106° 38' 50" W)*

D4.5 Ground Temperature

Mean annual air temperature data for 2001 were used in the absence of measured data. The following table presents the mean annual air temperature for each assessment unit:

Table D.18 Mean Annual Air Temperature as an Estimate for Ground Temperature

Assessment Unit	Ref.	Mean Annual Air Temperature (^oC)	Mean Annual Air Temperature (^oF)
NM-2106.A_10	(a)	6.62	43.924
NM-2106.A_12	(a)	6.62	43.924

Ref. = References for Weather Station Data are as follows:
(a) *New Mexico State University Climate Network (Jemez METAR, Elevation 2,438 meters; Latitude 35° 50' 28" N, Longitude 106° 37' 8" W),* ***2001***

ºF = Degrees Farenheit
ºC = Degrees Celcius

D4.6 Thermal Gradient

The default value of 1.65 was used in the absence of measured data.

D4.7 Possible Sun

Percent possible sun for Albuquerque is found at the Western Regional Climate Center web site

http://www.wrcc.dri.edu/htmlfiles/westcomp.sun.html#NEW%20MEXICO. The percent possible sun is 76 percent for July.

D4.8 Dust Coefficient

If a value is entered for solar radiation, SSTEMP Model will ignore the dust coefficient and ground reflectivity and "override' the internal calculation of solar radiation. Solar radiation data are available from the New Mexico State University Climate Network (see Section 4.10).

D4.9 Ground Reflectivity

If a value is entered for solar radiation, SSTEMP Model will ignore the dust coefficient and ground reflectivity and "override' the internal calculation of solar radiation. Solar radiation data are available from the New Mexico State University Climate Network (see Section 4.10).

D4.10 Solar Radiation

Because solar radiation data were obtained from an external source of ground level radiation, it was assumed that about 90% of the ground-level solar radiation actually enters the water. Thus, the recorded solar measurements were multiplied by 0.90 to get the number to be entered into the SSTEMP Model. Solar radiation data were not available for either the Jemez METAR or Coyote RAWS stations, so the nearest station with solar radiation was used. The following table presents the measured solar radiation at Tower RAWS station for 2001:

Table E.19 Mean Daily Solar Radiation

Assessment Unit	Ref.	Date	Mean Solar Radiation (L/day)	Mean Solar Radiation x 0.90 (L/day)
NM-2106.A_10	(a)	7-6-2001	584.184	525.77
NM-2106.A_12	(a)	7-7-2001	603.384	543.05

Ref. = References for Weather Station Data are as follows:

(a) New Mexico State University Climate Network (Tower RAWS, Elevation 1,981 meters; Latitude 35° 46' 45" N, Longitude 107° 37' 36" W)

D 5.0 SHADE

Percent shade was estimated for the assessment units using field estimations per geomorphological survey field notes from June 2001. The measurements were averaged along with visual estimates using USGS digital orthophoto quarter quadrangles downloaded from New Mexico Resource Geographic Information System Program (RGIS), online at http://rgis.unm.edu/. This parameter refers to how much of the segment is shaded by vegetation, cliffs, etc. The following table summarizes percent shade for each assessment unit:

Table D.20 Percent Shade

Assessment Unit	Percent Shade
NM-2106.A_10	0%
NM-2106.A_12	0%

D 6.0 REFERENCES

Bartholow, J.M. 2002. SSTEMP for Windows: The Stream Segment Temperature Model (Version 2.0). U.S. Geological Survey computer model and documentation. Available on the internet at http://www.fort.usgs.gov. Revised August 2002.

U.S. Department of Agriculture (USDA). 2005. WinXSPRO 3.0. A Channel Cross Section Analyzer. WEST Consultants Inc. San Diego, CA & Utah State University.

U.S. Geological Survey (USGS). 2002a. Input and Output to a Watershed Data Management File (Version 4.1). Hydrologic Analysis Software Support Program. Available on the internet at http://water.usgs.gov/software/surface_water.html .

U.S. Geological Survey (USGS). 2002b. Surface-Water Statistics (Version 4.1). Hydrologic Analysis Software Support Program. Available on the internet at http://water.usgs.gov/software/surface_water.html .

Theurer, Fred D., Kenneth A. Voos, and William J. Miller. 1984. Instream Water Temperature Model. Instream Flow Inf. Pap. 16 Coop. Instream Flow and Aquatic System Group. U.S. Fish & Wildlife Service, Fort Collins, CO.

Thomas, Blakemore E., H.W. Hjalmarson, and S.D. Waltemeyer. 1997. Methods for Estimating Magnitude and Frequency of Floods in the Southwestern United States. USGS Water-Supply Paper 2433.

Viger, R.J., S.L. Markstrom, G.H. Leavesley and D.W. Stewart. 2000. The GIS Weasel: An Interface for the Development of Spatial Parameters for Physical Process Modeling. Lakewood, CO. Available on the internet at http://wwwbrr.cr.usgs.gov/weasel/.

Waltemeyer, Scott D. 2002. Analysis of the Magnitude and Frequency of the 4-Day Annual Low Flow and Regression Equations for Estimating the 4-Day, 3-Year Low-Flow Frequency at Ungaged Sites on Unregulated Streams in New Mexico. USGS Water-Resources Investigations Report 01-4271. Albuquerque, New Mexico.